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FORESTRY RESEARCH PROGRESS IN 1973

McIntire-Stennis
Cooperative
Forestry
Research
Program

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COOPERATIVE STATE
RESEARCH SERVICE

U.S. DEPARTMENT
OF AGRICULTURE

This report reflects the progress of forestry research authorized by the following Act:



Public Law 87-788
87th Congress, H. R. 12688
October 10, 1962

An Act

76 STAT. 806.

To authorize the Secretary of Agriculture to encourage and assist the several States in carrying on a program of forestry research, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is hereby recognized that research in forestry is the driving force behind progress in developing and utilizing the resources of the Nation's forest and related rangelands. The production, protection, and utilization of the forest resources depend on strong technological advances and continuing development of the knowledge necessary to increase the efficiency of forestry practices and to extend the benefits that flow from forest and related rangelands. It is recognized that the total forestry research efforts of the several State colleges and universities and of the Federal Government are more fully effective if there is close coordination between such programs, and it is further recognized that forestry schools are especially vital in the training of research workers in forestry. Forestry.
Research pro-
grams, promo-
tion.

(Sec. 2-6 not included)

"Forestry re-
search."

SEC. 7. The term "forestry research" as used in this Act shall include investigations relating to: (1) Reforestation and management of land for the production of crops of timber and other related products of the forest; (2) management of forest and related watershed lands to improve conditions of waterflow and to protect resources against floods and erosion; (3) management of forest and related rangeland for production of forage for domestic livestock and game and improvement of food and habitat for wildlife; (4) management of forest lands for outdoor recreation; (5) protection of forest land and resources against fire, insects, diseases, or other destructive agents; (6) utilization of wood and other forest products; (7) development of sound policies for the management of forest lands and the harvesting and marketing of forest products; and (8) such other studies as may be necessary to obtain the fullest and most effective use of forest resources.

"State."

SEC. 8. The term "State" as used in this Act shall include Puerto Rico.

Approved October 10, 1962.

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FORESTRY RESEARCH PROGRESS IN 1973

Concern over the use and management of our forest resources, the goods and services they provide and the forest environment is increasingly evident. This growing awareness of the economic and social significance of forests is readily apparent in the increasing public demands for a role in policy decisions on the use of our forests and for better stewardship of all our forest lands.

The Nation's forestry schools are making every effort to respond to the many and varied demands on our forests' lands. The McIntire-Stennis Cooperative Forestry Research Act, now in its eleventh year, provides a major route through which the schools can contribute, both in research and in education, particularly graduate education.

The objectives of the McIntire-Stennis Cooperative Forestry Research Act are to 1) encourage and assist forestry schools to conduct research necessary to improve the production, protection and utilization of forest and related range lands and 2) stimulate

the training of needed scientists in forestry and related specialties. Cooperation is implied in the name of the program. The total program is cooperative both in funding and in the selection and design of research projects. Cooperative efforts include close coordination with the U. S. Forest Service, the various state forestry agencies and with forest industry.

This report for 1973 summarizes some selected program projects. The breadth of the program is indicated by the major topic areas which include renewing timber supply, protecting watersheds and water supply, managing forest wildlife habitat, providing for forest recreation, protecting forest resources, utilizing wood resources, planning for forest land use and innovative applications in forestry research.

I hope you find this report informative and interesting.



Robert E. Dils
President, ASCUFRO

ASSOCIATION OF STATE COLLEGE AND UNIVERSITY FORESTRY RESEARCH ORGANIZATIONS

The Association of State Colleges and University Forestry Research Organizations (ASCUFRO) was established in 1963. It serves as a vehicle for members to exchange views, formulate acceptable policy, and facilitate cooperation in the development and conduct of forestry research in the States. Location of members in all States constitutes a grassroots mechanism for identifying contemporary and pressing research needs. National and regional coordination is accomplished by ASCUFRO membership on ARPAC's (Agricultural Research Policy Advisory

Committee) National Planning Committee and liaison with ESCOP (Experiment Station Committee on Policy) and NASULGC (National Association of State University Land Grant Colleges). One method ASCUFRO uses to communicate among its members and with the interested public is through this Progress Report, for which ASCUFRO assumes publishing costs. Coordination of the Association's activities is by an Executive Committee, whose members are listed below:

ASCUFRO EXECUTIVE COMMITTEE

R. E. Dils, President
Colorado State University

J. L. Gray, Vice-President
University of Florida

R. M. Kallander, Secretary-Treasurer
Oregon State University

E. W. Pierson, Western Region
California State University

G. R. Stairs, North-Central Region
University of Wisconsin

L. P. Blackwell, South Central Region
Louisiana Tech University

D. E. White, Northeastern Region
West Virginia University

J. F. Hosner, Southeastern Region
Virginia Polytechnic Institute and State University

D. B. Thorud, West Central Region
University of Arizona

A second way ASCUFRO achieves research coordination is by close liaison with the Cooperative Forestry Research Advisory Committee established

by the McIntire-Stennis Legislative Act to advise the Secretary of Agriculture. The 12 members in 1973, appointed by the Secretary, were:

Federal-State Agencies

Theodore Natti
Department of Resources and Economic
Development
Concord, New Hampshire

H. E. Ruark
Georgia Forest Research Council
Macon, Georgia

Thadis W. Box
College of Natural Resources
Utah State University
Logan, Utah

R. Keith Arnold
Forest Service
U. S. Department of Agriculture
Washington, D. C.

William F. Hueg, Jr.
Agricultural Experiment Station
University of Minnesota
St. Paul, Minnesota

Private Industries

Clarence W. Richen
Crown Zellerbach Corporation
Portland, Oregon

John C. Burwell
Burwell Lumber Company
Idabel, Oklahoma

Casey E. Westell, Jr.
Tenneco, Inc.
Houston, Texas

Henry K. Trobitz
Simpson Timber Company
Arcata, California

William G. Westerdahl
St. Regis Paper Company
Bemidji, Minnesota

Paul M. Dunn
Consultant
Corvallis, Oregon

John M. Tully
Anderson-Tully Lumber Company
Memphis, Tennessee



RENEWING THE TIMBER SUPPLY

The Nation's timber supply comes from some 500 million acres of commercial forest land. Four million private owners hold 296 million acres, or 57 percent, of this land. Dispersed throughout the continental United States, these forests are proximal to the participating institutions in the McIntire-Stennis Program. Much of the research, locally conducted, aims at increasing the timber supply to meet our ever-growing demands for housing and other wood-based products.

To increase and renew that supply, forest scientists work in four areas

- More efficient silvicultural methods
- Tree improvement
- Regeneration
- Fertilization

and they are developing new production systems.

Silvicultural Methods

As a first step in renewing timber supplies, we need to be able to assess the growth of standing forests under a variety of regional conditions. Researchers in several States, especially Wisconsin, Indiana, California, Georgia, Virginia, Pennsylvania, and Minnesota, have formulated methodology and mathematical derivations that simulate growth and reproduction of mixed and pure stands of hardwoods and conifers—in both even-aged and uneven-aged forests. Through simulation, the scientists can determine forest growth conditions under an array of silvicultural practices; and they can find out which of these practices will achieve optimum growth. These models enable researchers to assess expected mortality of trees, consider aesthetic, wildlife, and

other forest values, and determine what potential exists for catastrophic losses to fire. Research in 1973 has advanced several practices that help increase timber supply:

- Prescribed burning reduces hazardous fuel and improves other forest components
- Optimum thinning regimes remove low-vigor trees and stimulate the growth of remaining trees
- Water control and addition of essential nutrients as fertilizers help correct soil deficiencies.

All silvicultural systems involve harvesting a portion or all of the trees. In some instances, clearcutting is useful and desirable; in others, it is not. Thus, research is focusing on alternatives. Oregon scientists underplant trees in fully stocked stands which will be both thinned and clearcut. Afterwards, the scientists can compare planting techniques and evaluate the two silvicultural systems.

Tree Improvement

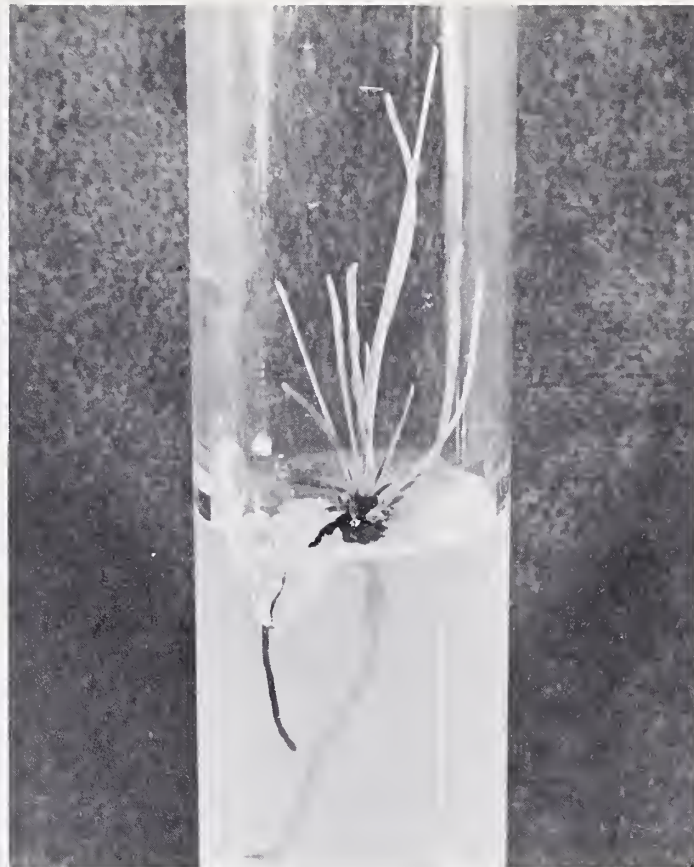
The exploitation of woodlands has left many acres not only understocked but also populated with low-grade trees whose offspring will be similarly poor in quality. Stands of sparse, undesirable parents are usually harvested, creating open space where trees are removed. This space must be filled with new and vigorous seedling trees. Researchers in several States have made great strides in selecting outstanding trees in the forest, proving their superiority in progeny tests, and establishing seed orchards of these superior-genotype trees. The trees produced grow straighter, taller, and faster than unimproved wild trees. Certain selections also resist insects and disease better. The "tree genetics approach" is useful in selecting trees that have elevated contents of turpentine chemicals. These chemicals are used to make consumer products—food flavoring, household deodorants, printing aids, and many others.

Once trees are proven superior in growth or resistant to pests, researchers must identify ways to improve the propagation of these superior trees

Wayne H. Smith, Cooperative State Research Service (CSRS), U.S. Department of Agriculture (on leave from the University of Florida) compiled and wrote this progress report. Others assisting him in the overall planning and preparation include Mason Carter, Purdue University and David Thorud, University of Arizona, members of the ASCUFRO Progress Report Committee; and Judith A. Armstrong, Aubrey E. Wylie, and Boyd W. Post, CSRS. We also acknowledge the assistance of numerous State research workers.



Forest geneticists choose superior trees from a tangle of culls to produce seeds and seedlings for reforestation. The man stands next to a super walnut tree selected in Kansas because it is taller, straighter, and bigger than its neighbors.



This southern pine seedling, produced from cultured tissue by Georgia forest physiologists, represent a major breakthrough. These seedlings planted in soil are growing, and without waiting several years for seed.



These hybrid poplars in Pennsylvania may be cut like silage, regenerated from root sprouts, and cut again to yield several tons of usable dry fiber.

through both vegetative and sexual reproduction. We have made considerable progress in this important area. In Georgia, scientists achieved a major breakthrough. They obtained plantlets from tissues of four important southern pines, species whose cuttings do not root easily. To our knowledge, these pine plantlets are the first ever to be produced in culture. This advance has unlimited possibilities in making rapid genetic improvement in forest trees. For example, offspring can be produced for evaluation quickly; we need not wait several years until the trees become old enough to produce seed. Only a small percentage of the nearly one billion seedlings planted in 1973 on some two million acres came from improved parents. When this effort is complete, all planting will be of superior genotypes.

Regeneration

After trees reach maturity and are harvested, rapid and efficient regeneration is essential to maintain the timber supply. Research has developed ways to enhance seed yields to ensure seedlings for the new forest. Soil preparation is often essential for the new seedlings to become established.

In Mississippi, Missouri, and other States, scientists plant tree seedlings in containers and place these directly into prepared soil. This new approach avoids the shock to seedlings of removing their roots from the soil. They need not endure adverse storage conditions, and they grow faster. Continued progress here will mean longer planting periods, reduced production time, increased efficiency, and improved survival of high-quality trees.

These containers hold seedlings from improved seed in Mississippi. Placed directly into soil, they grow rapidly and do not experience the shock of having their roots removed from the soil.



Fertilization

Fertilizing the forest to increase timber yield and other values is becoming an accepted management tool in forestry. Much of the research needed to develop wise use of fertilizers was completed in several of the States participating in the McIntire-Stennis Program. In Tennessee, research showed that juvenile yellow poplar and sweetgum would grow faster in response to fertilizers applied to soils of that region. California work revealed a growth response to urea nitrogen by 40-year-old Douglas-fir. Maine spruce-fir stands treated with a complete fertilizer (one that contains nitrogen, phosphorus, and potassium) produced 2.75 cords per acre more wood than on areas not fertilized. These responses coupled with marked responses by southern pine, especially in Florida, are encouraging. But we need more such research advances if future timber supply is to meet future demand.

A New Production System

Scientists have made considerable progress toward rapid production of a source of hardwood fiber needed for pulp products. The short-term production systems employ fast-growing species (e.g., American sycamore, hybrid poplar, river birch), established at close spacings and harvested like silage. Subsequent crops emerge as sprouts from cut stumps. In addition to devising cultural practices, the scientists have shown that the whole tree (stem and branches, wood and bark) yields fibers useful in the manufacture of construction board or pulp-derived consumer products. Future efforts must expand on aspects of this emerging research base. Requirements for wood-based products are estimated to be nearly twice current production by the year 2000. ●



PROTECTING WATERSHEDS AND WATER SUPPLIES

Clean water, clean air, and productive soil are precious resources. Much of the water we need for a variety of uses is filtered through the vast acreages of forest and range lands. Of the precipitation received in terrestrial landscapes, about 70 percent of this water is lost through evaporation and transpiration. Collecting, storing, conveying, using and reusing the remaining 30 percent is the subject of considerable research. In the McIntire-Stennis Program, scientists want to determine what type of vegetative structure will both permit dependable yields of high-quality water and also prevent sedimentation and wind and water erosion associated with floods. Project leaders are also using their findings to

- Restore landscapes that are disturbed, which affects water adversely and
- Renovate waters contaminated by municipal and industrial activities.

Water Supply

Forest cover largely determines the quality and quantity of water available for human use. In devising wise watershed management practices, the scientist first develops a hydrologic model for a forest. The model shows the output of water and chemicals based on the capacity of precipitation to (1) penetrate the forest canopy, (2) reach the ground, and (3) infiltrate and percolate through the soil. Research in Alaska showed that factors other than ground ice, snowmelt patterns, and soil depth are related to vegetational cover. Current effort is to define the soil factors that are involved. Scientists at several institutions have found that certain soil properties control the composition and growth of vegetation. They have also found that certain types of vegetation help prevent erosion by forming surface conditions that minimize runoff. For example, in New Mexico, researchers compared several forest communities with open meadows. They monitored soil water storage by using sophisticated neutron moisture-

monitoring techniques to predict water yield. Utah scientists have developed computer programs for a model that includes six parameters useful in predicting watershed runoff from summer rainstorms. Next, they will use the model to determine the effects of changes in land use on watershed function. In Pennsylvania and other locations, researchers have shown that clearcutting in one or two harvest steps resulted in different yields of water. The effect of the cutting method on water yield was greatest during the dormant season.

A second important source of our water is from snowpacks that melt in the forests. In Nevada, scientists developed a model that showed snowmelt was caused by temperatures inside the snowpack. The higher the interior temperature, the greater the amount of melted snow. The model can forecast where snowmelt runoff will occur and how much will occur each day. It can be used to help prevent floods and droughts and also can be applied in ecological, agricultural, and engineering fields.

Arizona researchers are developing a model to predict the timing and quality of runoff from the snowpack. This model involves determining the relations of forest density, type, and configuration to the solar radiation factors that affect snowmelt hydrology. Here we see the innovative application of the theory of radiative transfer. Originally developed for problems in stellar atmosphere, it can be applied also to radiation effects on snowmelt in forests. An important use of the model will be in estimating the increase in yield of high-quality water by harvesting forest strips that differ in orientation (cuts north: south versus east:west) density, aspect (north or south slopes), and canopy height.

Reforestation Disturbed Land

Forest scientists have made considerable progress toward determining what is needed to reforest disturbed lands and renovate waste water. These are lands that have been disturbed because of their use



Arizona scientists increased snowmelt, an important source of clean water, by developing forest cutting methods that collected more snow and reduced losses to evaporation.



How clean is the water, and how does a change in land use affect the quality of water-runoff from forests can be answered for this monitored watershed in South Carolina.



The immense acreage of our forests has potential for renovating waste water. Here, recreation area waste is being disposed of in a Missouri forest, where the soil-plant system will purify the water before it returns to streams and lakes.



in providing fuel for energy production, other mining activities, agricultural practice, or grading and filling associated with residential development activities. Such lands often have poor hydrologic characteristics and represent harsh environments for establishing vegetation. For example, soil and root microorganisms important in the establishment of forest vegetation may be eliminated by disturbance and thus prevent reforestation. In Michigan, scientists have examined populations of microbes in soil disturbed during copper and iron mining activities. They found different levels of both bacteria and fungi in the two types of disturbed soils. These differences may be important in how effectively nutrients are converted and absorbed by the new vegetation. The nutrients are essential for the growth of healthy forest vegetation. If we can find out which vital microbial process (conversion or absorption) is halted because the soil is disturbed, we can inoculate the soil and restore the process.

Dark coal spoils in West Virginia cause thermal climates so harsh that plants cannot grow. There, scientists found that treating the surface with a common whitewash increased the soil's ability to reflect heat and lowered surface temperatures to a level that enabled native hardwoods and grasses to survive. In Georgia, scientists successfully reclaimed China clay (Kaolin) spoils by seeding, mulching, and fertilizing the trees, grasses, and legumes. Kansas researchers determined which forest species is best for commercial and esthetic plantings on strip mine spoil and what requirements are necessary for planting stock and grading spoil. They compiled this information in a guide for planners interested in reclamation and conservation of mine spoils. It is important to reestablish forest vegetation in areas where it has been destroyed because this restores water infiltration and percolation. It also reduces surface erosion that results in soil and nutrient losses from the site and pollution of nearby streams.

Water Quality

The flow of nutrients from land to aquatic ecosystems is essential in support of the life processes of animals, plants, and insects associated with lakes and streams. If nutrient amounts in this flow become too great, the quality of water is lowered. But how great is too great? Numerous researchers are attempting to determine the natural or baseline levels of nutrients in water and what levels of nutrient movement are required from the forest to supply and maintain other ecosystems. With this information, they can devise harvesting methods and liquid waste disposal procedures that will minimize adverse impacts on the environment.

Results from skyline harvesting research in Oregon are currently being used to reduce logging costs in small timber and to determine optimum harvesting systems in certain fragile terrains. Animal, municipal, and pulp mill effluent must be disposed of somewhere in some way. Scientists in several States are working toward procedures for disposal in forested watersheds that will not harm the quality of the water. Pulp mill effluent can best be applied to porous sandy soils supporting trees whose nutrient requirements are low, according to first-year results from Texas. Maryland researchers used forest and grass buffer strips to control animal waste runoff. When the scientists monitored streams below the area treated with manure and within the same watershed, they found no evidence of fecal pollution. The fecal organisms, nitrogen, phosphorous, potassium, and sodium had moved less than 25 feet from their disposal site. These examples point up the potential for using the vast acreages of forest to renovate wastes in environmentally acceptable ways. ●

Opposite page: Mine spoil revegetation methods (right) developed in Kansas can reduce soil erosion, sedimentation, and stream pollution, which occurs on disturbed lands (left) not reclaimed.



MANAGING FOR FORAGE AND HABITAT

A forest habitat is a resident site and a major source of food and cover for a variety of animals. Many species of wildlife, including game animals, depend on naturally occurring food and cover for their survival. Today we see both changing land-use patterns and practices and rapidly escalating interest in consumptive and nonconsumptive uses of wildlife. Clashes among these uses can arise. Further, ground cover plants in forests are a valuable food resource for domestic livestock. Forest ranges go far toward increasing consumptive protein in the diet of Americans. Concurrently, they provide watershed protection and recreational opportunities. One aim of the McIntire-Stennis Program is to blend the needs of animals, humans, and the forest into a reasonable, balanced whole.

Wildlife Habitat

To protect and manage the wildlife we enjoy, we need ecological, biological, and behavioral information. For example, animals sometimes interact competitively and one population may decline as a result. Researchers in Connecticut have concluded that a particular species of cottontail rabbit is rare and perhaps endangered in southern New England because another rabbit species invades and occupies its range. One way to help sustain a large animal population is to determine what plants will supply the nutritional sustenance of the animals and to ensure that enough of this food exists when it is needed. Researchers in Louisiana characterized the food plant species for white-tailed deer, a prized game species. In New Jersey, scientists used computer-generated maps to display the distribution of the oak species that produced acorns eaten by deer. These graceful creatures also live in the Pinyon-Juniper forests of New Mexico. There, scientists fertilized the habitats; and, as a result, the deer browse contains greater crude protein content, essential for the animal(s) nutrition. Birds, especially ducks, often depend on the forest to survive. In

Louisiana, scientists showed that numbers of wood ducks in an area are strongly correlated with the types of forest habitats in the areas. Virginia researchers applied knowledge of basic reproductive biology to determine the health and ecological requirements for several economically and esthetically important wildlife species. Pennsylvania scientists found a disease that had cut the elk herd 50 percent while legal and illegal kills had taken only a few deer.

Using computer technology, Virginia researchers modeled the interactions of deer with regional land use and forest management practices. These models use measures of land in forest, crops, and pasture for development of regional wildlife management units. Another model incorporates energy supplies, environmental chemicals, and sex factors to determine herd birth rates. Using these models, forest resource managers will be able to assess the consequences of a proposed management scheme in the region before they implement it.

Range Quality

On a wisely managed forest range, there is forage for cattle and sheep, habitat for important wildlife species, and protection for watersheds. Ranges producing high-quality forage to be converted to animal protein are increasingly important in ranch management. To meet our protein requirements, managers must provide year-round forage for their animals. One way to improve the range is to eliminate unpalatable brush species in favor of nutrient-rich grasses, herbs, and shrubs. For example, scientists are replacing thistle with bunch grasses in Washington, and saw palmetto and gallberry with maidencane and other nutritious plants in Florida. Forest management practices can be compatible with good range and wildlife practice, as shown in Florida research. There, mammal and bird species preferred the prepared forest sites. At the same time, forest fertilization increased the quantity and quality of



Pennsylvania scientists found that deer (right) are attracted to the abundant browse food on recent clear-cut areas. Deer populations, uncontrolled, can build up and consume the regenerating forest trees unless these are fenced (left).



One cottontail rabbit species is disappearing from Connecticut woodlands, apparently because of dominance by another, more aggressive cottontail species.



A North Carolina woodland can carry more squirrels when artificial den boxes are provided to supplement natural food and cover.

desirable forage species for range cattle and wildlife. Grazing management, according to Idaho researchers, is also important in sustaining the range resource. It can help to provide forage for domestic stock in the least competitive manner to wildlife and other land use values. Scientists in California found that desirable forage plants decreased when California ranges were grazed in April, compared with those grazed earlier than April. The scientists on this project plan to complete it by devising a predictive model showing the effects of weather and grazing management on animals, forage, and water production. ●

Arizona scientists developed ways to remove brush by using prescribed fire, make openings by harvesting mature forest strips and use grazing management to improve Arizona range for domestic livestock and wildlife.





PROVIDING FOR FOREST RECREATION

Forest landscapes are a valuable resource. Many of us enjoy their beauty during our leisure time. McIntire-Stennis Program research on forest recreation involves sociological and psychological studies in addition to studies of design, management, and monitoring. Urban populations increasingly use the forest for recreation, but not without causing severe stress on the forest environment. Forest scientists want to minimize such stress, heal its effects, and also enable us to continue forest recreation.

Preference and Perception

What makes a forest desirable for recreation? This depends partly on how users perceive the landscape. In assessing the aesthetic appeal of forests, New Hampshire scientists have found that spatial arrangement, horizontal order, visibility, mobility, and variety are important factors. Other landscape attributes also affect preference; for example, mountain scenery and a lake for fishing were important elements in selecting recreational areas, according to a North Carolina study.

In Minnesota, researchers are developing ways to assess preferences and perceptions of potential recreationists. They have used photographs to obtain information useful in designing new parks. Tennessee scientists believe that recreational opportunities provided for users should be designed according to the characteristics of the recreation clientele. The Tennessee study showed that education and income level largely determined the preference for hiking over other forms of outdoor recreation. The complexity of determining and properly using such information is compounded because populations using the sites can change. For example, in North Carolina, a decline occurred over time in the number of recreationists who preferred a tent pad and moderate shade on the site. More users wanted heavily or lightly shaded sites.

The importance of knowing the user was emphasized further by research in Washington State. There, scientists found that wildland users were mostly urban families who stayed two nights on their first visit and preferred campsites near a lake, the primary attraction.

Resource Allocation

Once demand and specifications for landscape elements and facilities are known, suitable forest land resource units must be selected for recreation and other uses and they must be properly developed. Researchers devised a method to determine the segments along Indiana rivers suitable for recreation and the ways these could be used for hiking, horseback riding, cycling, and other activities. Landscape, user, and econometric analyses are important in allocating both fiscal and physical resources to recreational land use. Making and implementing such decisions is also shaped by prevailing outdoor recreation policy—especially that existing among Federal land-managing agencies. Research in North Carolina identified the Congress, clientele and the Administration as major influences on recreation and recreation policy.

User Conflict and Impact

Conflict emerges within various user groups and between users, landowners, and land managers. Vermont studies have shown that disagreement can be expected to occur on one out of every four recreational occasions. Determining ways to manage conflicts is a challenge accepted by researchers in the McIntire-Stennis Program. Clashes also develop between recreation use and the ecologic systems chosen for the outdoor experience. In New York State, scientists found that landowners who reforest land were more likely to restrict recreational use by snowmobiles because they damaged tree seedlings. Forest landowners generally objected less to use of



New Jersey, forest recreational use can cause landscape abuse by destruction of ground cover (left).

Finding out what people there want from recreation areas and what their attitudes are (right) helps determine proper management for this forest.

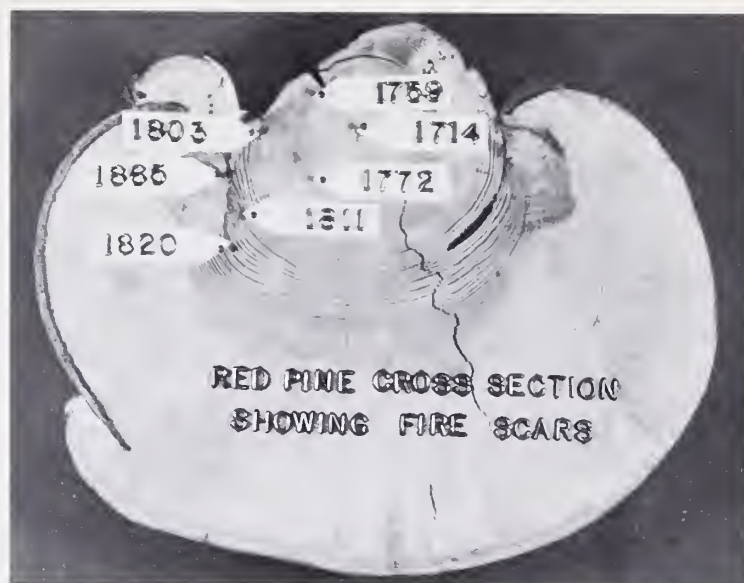


Managing conflict in uses is important to forest recreation. Skiers, hunters, and forester often encounter use problems with snowmobilers when in the same forest.

their woodlands by hunters than by snowmobilers. Other conflicts being studied are those between snowmobilers and skiers and snowshoers. Louisiana research showed that users often trampled and destroyed the vegetation and caused soil compaction. Both results degrade natural beauty and lead to erosion. Researchers in New York and elsewhere are trying to determine

- The carrying capacity of recreation sites
- What types of vegetation are most adaptable to molestation
- Ecologic and other means of dispersing users
- Requirements for site recovery
- Means of waste disposal.

These aims are all part of the effort to devise effective management for forest recreational resources. ●



Fire has many faces. A 1714 wildfire destroyed a mixed forest in Minnesota. Red pine now there shows evidence of five other wildfires (top). But excluding prescribed fire from forests promotes brush growth and prevents pine regeneration and recreational access to the majestic forest park (above).



UTILIZING WOOD RESOURCES

Our demand for forest products is expected to increase 80 percent by the year 2000. At the same time, forest acreage is diminishing, and so is the supply of the larger, better quality trees. This year, 1973, is the third straight year beginnings have been made on over two million new homes. This fact, plus the energy crisis, focuses interest on forest products as low-energy conversion material. Steel and aluminum require, respectively, eight and 44 times as much energy as wood for conversion to usable products. Further, petrochemicals as a raw material for plastic products are scarce. But such products can often be made from the forest. In total, we enjoy over 5,000 wood-based products.

Utilization

One way to get more products from the forest is to get more use from each tree. Such use needs to be judicious, however, and some research aims at determining the proper balance. For example, the recycling of nutrient-rich crowns of trees is important in the ecologic cycling of nutrients in the forest. Thus, we may not want to remove all crowns to use elsewhere. The initial thrust has been toward fuller use of materials already removed from the forests. Scientists in several States have found that waste bark can be used satisfactorily to construct particleboard. By studying bark chemistry, California researchers found they could use a bonding agent from bark extracts to bond particles together to make weatherproof board. In Massachusetts, researchers developed a low-density board from limewood mixed with polyurethane. Particleboard of good quality was constructed through research at Alabama and Illinois. The scientists used a variety of wastes, including bark, corn cobs, and corn stalks. The boards were often improved by using wood veneer or plastic faces over the particleboard. Idaho researchers developed sawing equipment and methods to reduce sawdust, while in Kentucky, scientists improved the yield from hardwood logs. They de-

veloped a mathematical simulation model for logs to determine the best sawing methods.

To meet demand for forest products, we now need to use a greater diversity of species and sizes of trees. Research has revealed the important properties of a number of "cull" species that are usually not harvested. Knowing fiber characteristics such as specific gravity, fiber length, cell wall properties, and earlywood proportion, Oregon researchers have progressed toward predicting the quality of hand-sheets manufactured from fibers of single "cull" species and from a mixture of fibers of two or more species. Similar research has paved the way for using small cull trees as a source of fiber in blends or as a source of lumber and chips from material that was previously thrown away.

Safe Products at Lower Cost

The prices we pay for forest products can be reduced by improving the methods of processing, preserving, and using wood products. Prefreezing or drying two prized woods, walnut and redwood, causes less wastage and improves drying quality, according to procedures developed in Minnesota. More effective ways to preserve oak were discovered by Illinois researchers, who determined the proper wood moisture content, temperature, and pressure for optimum absorption of preservatives. Michigan scientists developed proper testing procedures to make the fullest and safest use of wood for home construction framing. In Mississippi, scientists found that the life of plywood and particleboard used outdoors can be extended by overlaying these construction materials with plastics or surface chemicals. All such research assures us of higher quality, longer lasting forest products, at a lower cost.

Cleaner Wood Processing

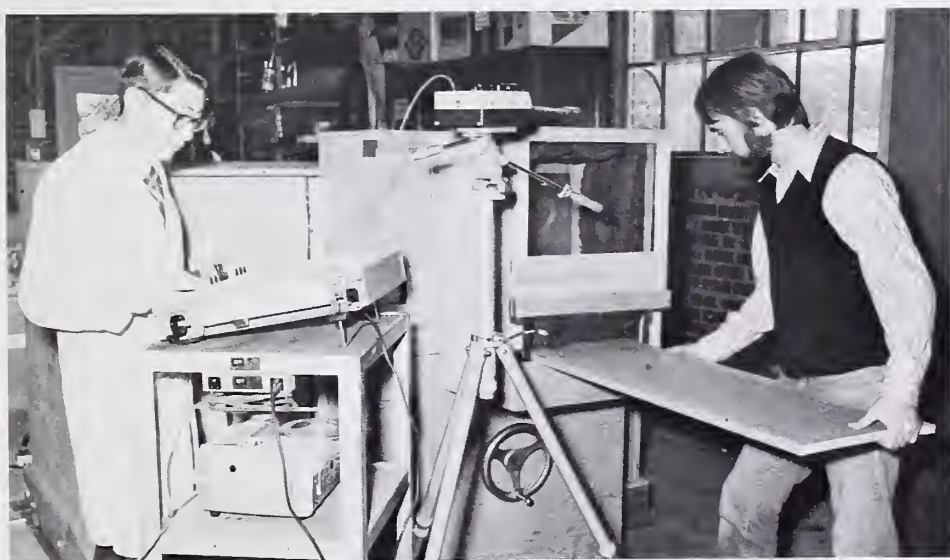
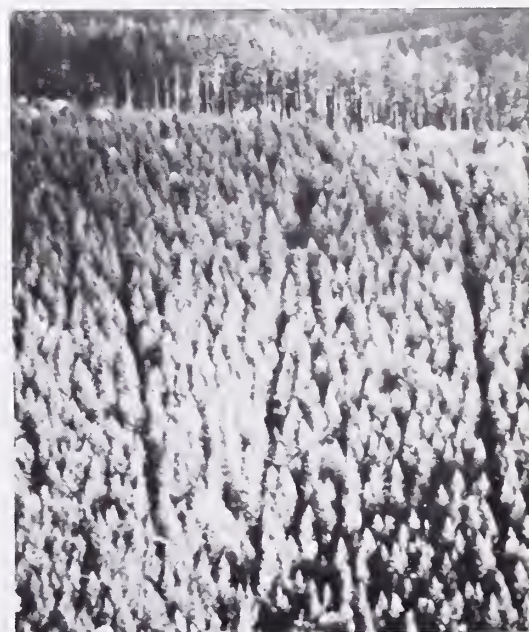
Forest scientists also work toward ensuring a more wholesome environment. Kentucky researchers,

starting at the wood-working site, developed a low-cost system that reduces planer noise below the standards set by the Occupational Health and Safety Act of 1970. North Carolina scientists have produced pulp by a new process that does not include odor-producing sulfur. Further, this process yields more pulp than the kraft procedure. Also, less energy is needed to beat the pulp. Next, the scientists plan to develop sizing and paper-making procedures for this new fiber material. Other research is aimed at using the wastewater from pulp mills to produce other byproducts. At the same time, the scientists want to develop more environmentally acceptable renovation steps, such as spraying effluent in the forest so that the water is filtered before returning to surface supplies. ●

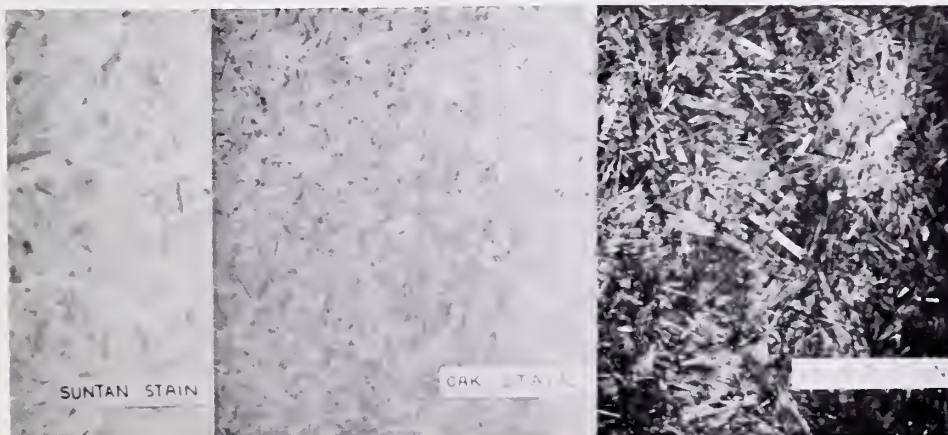


Pulp mill effluent is a major waste product in wood fiber processing. Texas scientists developed procedures for spraying it on certain lands in that area.

Half of the saleable stems in this Oregon forest were removed by skyline roads. This new harvesting technique useful in some areas, minimizes disturbance to the forest. (Note: Three skyline roads in photograph)



Use of devices to reduce wood planer noise, developed in Kentucky wood processing mills, make them safer places to work.



Boards are now made from a variety of wood and waste materials once considered unusable. Flakeboard developed in Maine may be used directly in construction or improved by covering with plastic.



PROTECTING FOREST RESOURCES

In recent years, we have lost billions of dollars annually because of damage by insects, diseases, and fires in our forests. The damage to timber, esthetic appeal, recreational opportunities, and watersheds can reach catastrophic proportions. Trees may be killed outright. Or they may be weakened to the point that otherwise harmless pests or climatic extremes will destroy them. Often, these damage agents are natural components of forest ecosystems. The challenge for researchers in the McIntire-Stennis Program is to try to define what factors—type of stand, climate, soil litter—lead to epidemic populations of insects and diseases and disastrous wild fires. And, once a harmful agent has reached serious proportions, they must devise control strategies to reduce the destruction to a tolerable level. The emphasis is on biological or silvicultural control. But, at times, immediate needs may require the use of chemicals to attain initial control.

Insects

Numerous insects have the potential of exacting a heavy toll of trees and forest habitats. Some of these currently under study are the seed moth, ponderosa pine cone beetle, maple worm, spruce budworm, pales weevil, elm span worm, and dioryctria coneworm. Seed and cone insects do not kill trees. But they do eliminate seed production from orchards of superior genotypes that are needed to supply the nearly one billion seedlings required annually for reforestation. Research has shown that dioryctria coneworm can apparently be controlled

- Biologically, by using a bacterial pathogen of the insect.
- Chemically, by using sprays of selected foliar-applied insecticides or soil-applied systemic chemicals.

The Gypsy Moth Once considered a minor pest, the gypsy moth has become a severe problem in the Northeast. These voracious insects have caused ex-



A.



B.



C.



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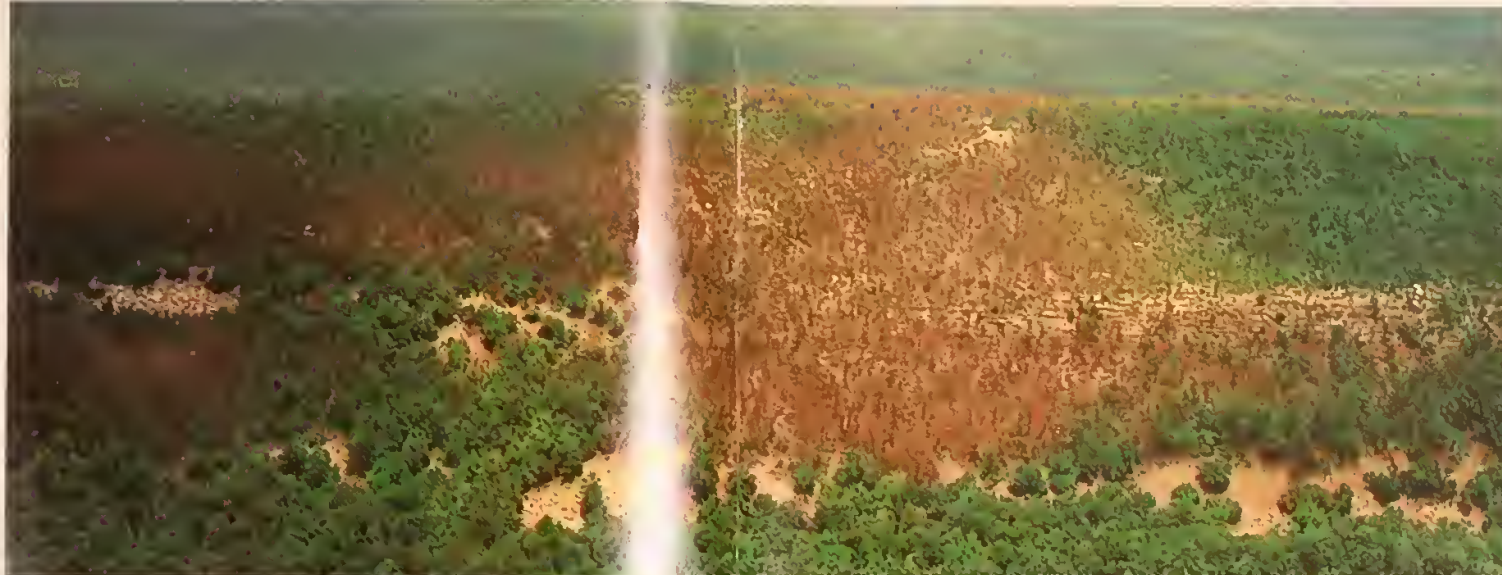
The Gypsy Moth Once considered a minor pest, the gypsy moth has become a severe problem in the Northeast. These voracious insects have caused ex-



A.



D.



B.



C.



E.



F.

A. This mature larva of the gypsy moth eats leaves of hardwood trees. The result is unsightly views, fire hazards, and weakened trees.

B. A massive attack by the gypsy moth defoliated this New Jersey forest.

C. The Douglas-fir tussock moth has attacked thousands of acres of Northwestern forests (brown). Watershed damage, soil erosion, fire, disfigured landscapes, and timber losses are the consequences.

D. The Southern pine beetle has killed patches of Southern pine over vast areas of the South, causing losses of timber and harm to the forest.

E. When this colorful, harmless-looking larva of the tussock moth feeds year after year on the foliage of Douglas fir, severe damage to the trees occurs.

F. White pitch tubes extrusions are telling signs that the deadly Southern pine beetle is loose in the forest.

tensive defoliation of forest, park, and suburban trees. In Rhode Island and Connecticut, scientists want to determine the impact of gypsy moth defoliation on tree mortality. Mortality was greatest among oaks in Connecticut, especially when they had been severely defoliated in their second year.

New Jersey researchers are evaluating biological control of the moth with the nuclear polyhedrosis virus. They hope to characterize the most effective virus strain by obtaining response curves for deaths of gypsy moth larvae that are fed the virus. And the researchers want to determine the synergistic effects of chemical stress agents. They are also examining the effects on gypsy moth metabolism of insecticides applied to the surface of or fed orally to the insect. They determined that 78 percent of orally administered DDT appeared in the feces, but when applied to the surface of the insect, 80 percent of the DDT appeared in the body of the larvae. The capacity of insects to metabolize insecticides greatly limits usefulness of the insecticides.

New Hampshire scientists tried to control the moth with beetles but the beetles' limited activity and movement did not provide encouraging results. In Maine, research included a survey of gypsy moth parasites and the production of genetic intersexes through crossings with foreign gypsy moths intended to produce sterile offspring. Sex attractants were used successfully in Connecticut to trap gypsy moths to determine population levels and mating pressure. Other researchers there tested *Bacillus thuringiensis* (a parasite) and synthetic pyrethroids (pyrethroids are chemicals occurring naturally in plants) sprayed on the larvae of the gypsy moths. Using the biological control procedure, scientists halved the percentage of defoliation and reduced living larvae fourfold. Although a diversity of approaches are under investigation, satisfactory control is not yet possible.

The Douglas-Fir Tussock Moth Another major menace, this time to some Western forests, especially in Washington and Oregon, is the Douglas-fir tussock moth. Not only has it defoliated thousands of acres causing unsightly views, but it also has reduced timber growth and threatened other forest values, including watersheds. Scientists in the State of Washington have shown that epidemics of another pest, the fir engraver, are associated with outbreaks of the tussock moth. As a result, trees are weakened and made susceptible to other pests. Forest entomologists in the proximal States are combining their efforts to use sex attractants, pest pathogens such as

viruses, and other agents to predict the development of population levels of insects that could cause severe problems and devise integrated control strategies.

The Southern Pine Beetle An insect that has spread to alarming proportions in the vast pinery of the South is the Southern Pine Beetle. Georgia scientists have found that insecticides produce discouraging results. Consequently, they are concentrating on using parasites of this dreaded pest to reduce its reproduction and parasitic efficiency. Other work has focused on precise determination of the life history of the beetle plus the condition of trees attacked by the pest. Thus, potential outbreaks can be anticipated and a control strategy devised. Because these beetles, like other forest insects, are natural residents of the forest habitat, a workable control procedure will not come fast or easy.

Diseases

Forest pathogens are numerous and usually omnipotent. Some pose continuing threats in nurseries and seed orchards, on which we depend for seedlings to meet the reforestation challenge—in plantation and natural forests and on trees in urban settings. Alabama scientists have made progress toward controlling *Phytophthora cinnimomi* disease with another soil fungus (*Trichoderma*). Several States are working to develop the tree's own genetic resistance to stem rust of pine, blight of chestnut, Dutch elm disease, leaf rust of eastern cottonwood, and verticillium wilt of elm. Both cases exemplify biological control. Progress has occurred nationwide toward understanding the ecology and control of a number of other tree diseases. Though no sure control exists, Wisconsin scientists have found several effective control measures that prevent both local and long-distance spread of the oak wilt fungus. Root diseases are being studied for several trees (aspen, hemlock, fir, oak, and maple, among others). Leaf and shoot diseases on pine, fir, spruce, and oak represent another focus. Also being studied are;

- Virus-like diseases on oak, sassafras, and black gum;
- Air and soil pollutants (SO₂, O₃, heavy metals) on pine and sycamore;
- The mycorrhizal soil fungi that protect roots against pathogens during the important establishment phase of forest species.

Fire

Fire, like pests, is natural in the forest. But, like pests, it can be catastrophic if it is uncontrolled. Fire can either destroy the forest directly or injure trees in such a way that they become prey for insects and diseases. Properly handled, fire is an important ecological force. We use it to aid in cycling nutrients, ecological succession, and pest management. Also, we use it to improve wildlife habitat. Above all, a controlled fire reduces fuel that can cause destructive wildfires. Montana researchers, recognizing these advantages but aware of smoke hazards, have made progress toward defining proper ways to disperse smoke. Similar research on fire as an ecological tool is underway in several States. ●

Prescribed fire used under controlled conditions reduces fuel and protects forests against wildfire, while improving the quality of wildlife and range.





PLANNING FOR FORESTLAND USE

Land prices continue to rise. Demands for a variety of forest resources increase. Thus, additional investment alternatives become available. As land use becomes more diversified, more acres of woodlands formerly managed for timber become subject to other managerial goals. The objective of the McIntire-Stennis Program is to help develop the fullest multiple-use potential of forest land. The scientists further want to devise decisionmaking models for alternative land uses which will provide the greatest social and economic benefits to all.

Inventory

Wise planning for forestland use begins with an inventory of forest land classes and an analysis of demands for each resource from such land. Researchers in several States have developed innovative ways to use satellite, U-2, and low-flight imagery to inventory lands and determine their use capability. After defining soil and landscape features that determine land capabilities, Colorado researchers made progress toward computer-generated maps that show planners the current and potential land uses. Similarly, New York scientists are translating remotely sensed information into landscape classification units related to land use for vacation home development. These examples typify the nationwide effort.

Some land, though inventoried for the several forest resources, is removed from the inventory for other uses. Such removals and a multitude of other factors will result in policy constraints on the supply of forest resources. California researchers have devised a computerized system for assessing the several factors that affect long-range timber supply prospects in the State. Those who evaluate the output from such models will be able to assess shifting demands among public and private lands. They will also be able to determine what degrees of management are needed for the marketable resources. Steps have been taken toward improving multiple-use decision

models. Scientists in Iowa, Michigan, West Virginia, and elsewhere have developed more reliable assessments of informational needs and systems and have improved managerial goal planning. They have devised procedures to incorporate the need for and best use of the public in forestland resources management decisionmaking.

Alternative Management System

The highest and best use of some lands is for intensive timber production. At times, conflicts arise with other land use and users. Considerable progress has been made in efforts to minimize such conflicts and to optimize values from the forestland resource. Wisconsin scientists evaluated economic restraints for even-aged contrasted to uneven-aged management—to find the most economical approach. Though planting trees in plantations emerged as the most productive economically, this method was esthetically unappealing. A test for psychometric reaction to even-aged management was devised in Virginia to determine reactions to the method.

The wildlife population in Mississippi changed when the forest was converted to even-aged units. Such a population change can either increase or decrease certain wildlife resources, such as deer, quail, and certain songbirds. One goal is to develop a model that includes several land uses and optimizes several management objectives for land use. When the Mississippi studies are completed, future analyses may reveal the proper size and mix of even-aged units within a mosaic that will be uneven in age and will fit such a model. California scientists developed psychometric tests for use in user conflicts in primitive wildlands. Their approach may also apply in user conflict in wilderness areas and in related management decisions.



Forest, range, and agricultural lands, plus lakes, streams, and prominent landscape features were identified with acceptable accuracy by California scientists using multiband imagery from the first ERTS satellite. Inventorying resources is the first step in land use planning. (Black areas in right photo represent water.)



Forest land resources analyzed in Indiana led to the recommendation that this section of a scenic river be protected.

Management Objectives

How we use forestland depends on objectives of the owner, demand for forest products, inherent capability of the land, and policies affecting land use. On industrial forestlands, management usually sees timber production as the dominant use but develops other uses where profitable or otherwise prudent. However, most forestland is owned by small investors whose objectives vary. As an illustration of this point, Mississippi research revealed that 75 percent of tree-farm owners were about equally distributed among wage earners, businessmen, and retirees—only 6 percent were farmers (farmers comprised 16 percent of those not owning tree farms)—Chart 1. Use objectives of the landholders varied; timber growing ranked from a poor second to no consideration for almost half the owners. Forest management was strongly associated with size of holding. An Oregon study revealed that 14 percent of the landowners identified timber production, recreation, farming, and grazing (i.e. multiple use) as their management objective. Nine percent had the single objective of timber production. Most owners favored public assistance in cost-sharing to achieve wise management, but only 12 percent knew about the Agricultural Conservation Program (REAP). Leasing to improve management was considered unacceptable to 88 percent as they preferred full control of their land. These findings clearly identify the need to develop incentives, practicable management information, or both, for these small owners. They will thus be able to make the best use of their resources to provide goods and services the public at large is increasingly demanding from the forest. ●

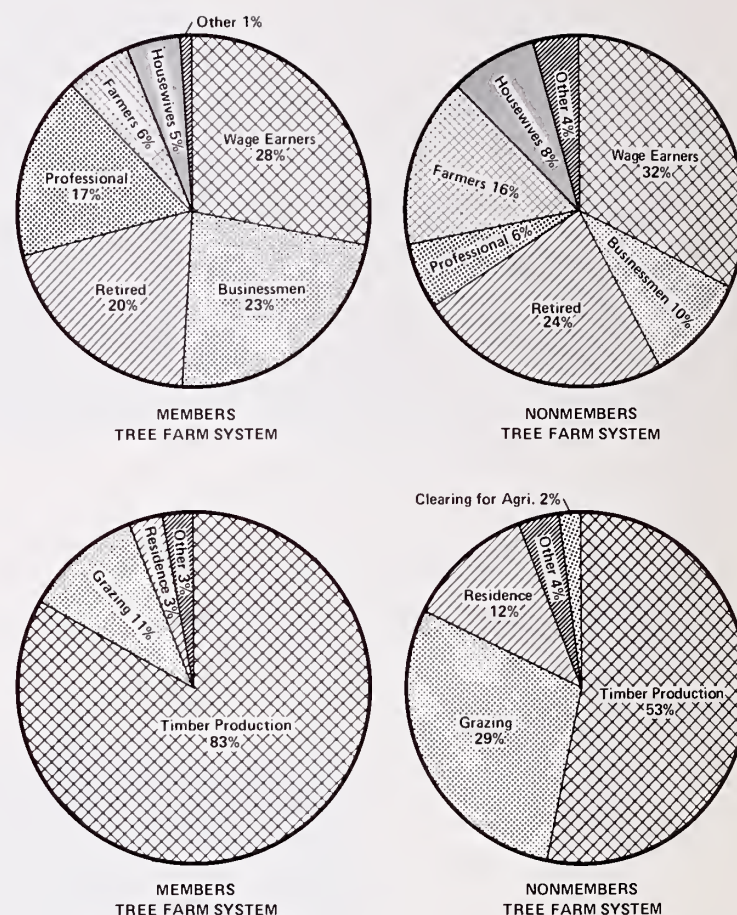


Chart 1. Research toward proper management can now proceed in Mississippi more rapidly after determining current ownership and use of nonindustrial private forest lands.



INNOVATIVE APPLICATIONS IN FOREST RESOURCES

Increasingly, forestry researchers are using modern, innovative techniques in their work and they are finding that wildland information can often be applied to urban and suburban problems. The natural beauty of trees and forest translated to cities can screen junkyards and highways, suppress noise, filter dust from the air and provide other amenities to enhance the environment. Some of the techniques involved include advance remote sensing, biological procedures, and data processing technology.

Urban Forestry

Forest trees have been used for a long time as windbreaks to protect and improve yields from agricultural crops. Urban application of such knowledge is increasing. Nebraska and North Dakota researchers are learning how these plantings affect wind movement as well as diversity of flora used for browse by certain large animals, and how these plantings serve as a reservoir for insects. These characteristics of forest strips or open space apply to urban settings because they can enhance the environment and have potential for recreational use. Systems for inventorying urban forests were developed in Massachusetts and North Carolina. The scientists can assess the quantity and quality of the resource and its distribution relative to population centers. They can also monitor shifts in land use that affect the availability of open areas. Remote sensing techniques are used, including satellite imagery enhanced by color additive viewers. Sequential photographs of urbanizing areas coupled with hydrologic data were used by California researchers to provide baseline data. These data, in turn, help measure the effect of construction activities on vegetation in urban green space. Vegetation is important in preventing excessive streamflow and harsh microclimate.

Urban activities affect both plant and animal life, sometimes adversely. The sensitivity of several tree species to pollutants common to cities was evaluated

in Illinois and Louisiana. Sycamore was the most sensitive, southern pines intermediate, and tupelo gum least sensitive to ozone pollutant. Pine and yellow poplar displayed damage from sulfur dioxide. The growing temperature of the tree was important in determining damage to the tree by the air pollutant. Connecticut scientists found that lead near roadsides was sufficiently high to inhibit mycorrhizal fungi, while nickel and cadmium were not present at toxic levels. These fungi are often essential to the establishment and growth of tree species. Small mammals forage vegetated highway rights-of-way; wild turkeys use nearby forested strips, according to West Virginia researchers. They have also demonstrated that voice-prints (sonagrams) can be used to census game birds who frequent the woodlands. Using voice-prints, they can "inventory" birds without capturing, marking, or molesting them in any way—even without seeing them. Computer costs are high, however, because of the complexity of the analyses. Other scientists have used radio transmitters to monitor the use of green space by wild animals with large home ranges. After identifying resident urban wildlife, Delaware researchers have determined the vegetational requirements from urban forests for food and nests of two important wildlife species.

Energy Concerns

The intensification of energy concerns has had its effect on forestry researchers. Extensive research is progressing on reforesting spoils from coal strip mining. In other efforts, Pennsylvania scientists have expanded the use of solid wood wastes for energy production. They also determined the combustible energy in waste materials for a number of manufactured wood products—newsprint, cardboard, etc. They found that the moisture content of the residue was strongly related to the combustible energy in the waste product.



Video tapes of bolter sawing operations were analyzed in Maine to combat worker fatigue and to devise more efficient use of people and machines.



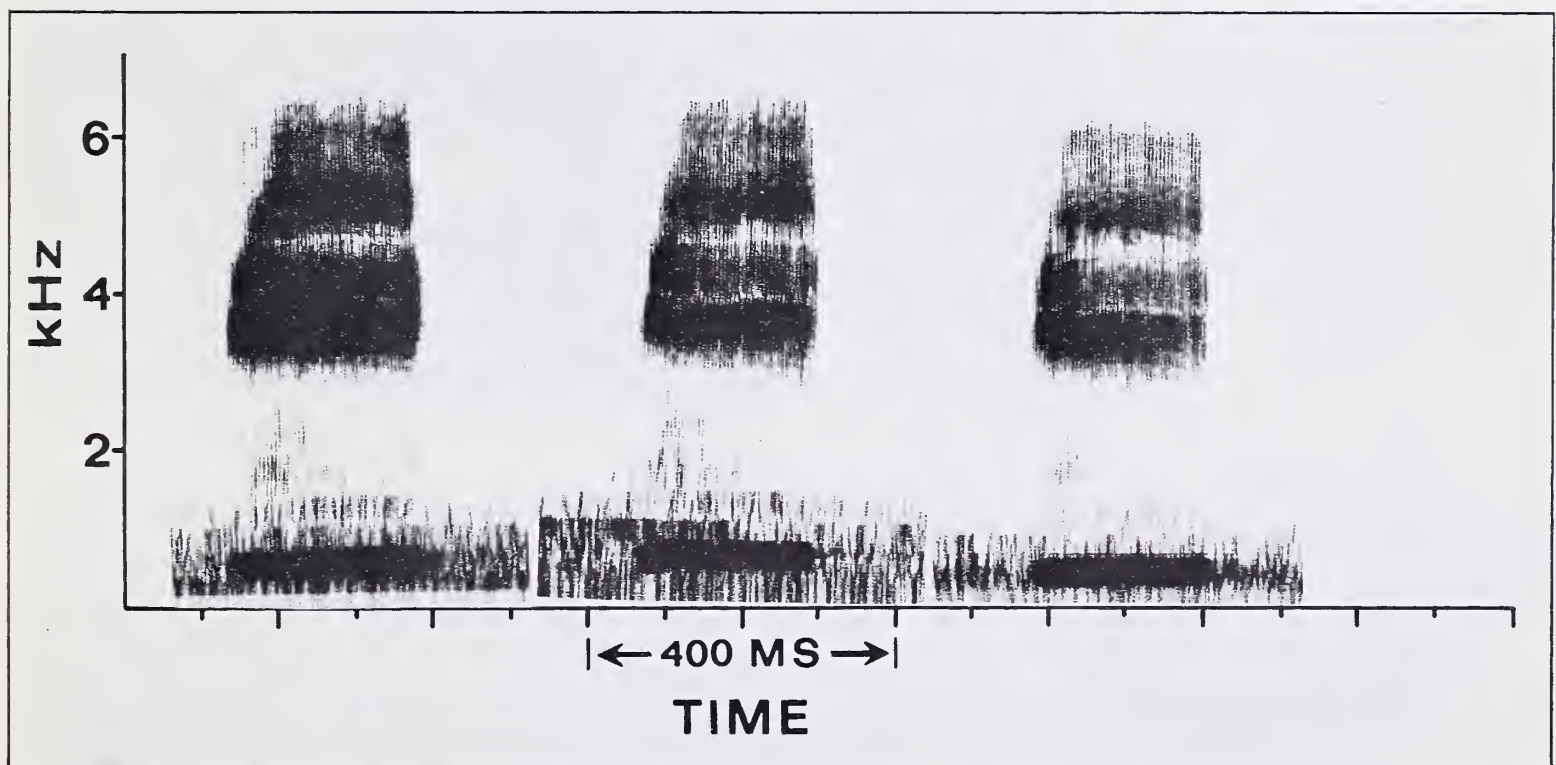
Radio transmitters placed around the necks of elk allow Montana researchers to determine what areas of the forest the animals use most.



Wildland technology is being adapted to urban forests. The aim is to provide visual screening, recreational opportunities, and other amenities to improve city life.

Resources Evaluation Technology

Several colleges and universities made substantial progress toward applying new approaches to problems that involve wise management and use of forest resources. These approaches include systems analysis, operations research, advanced data processing, and thermal and multispectral, color-enhanced remotely sensed imagery. For example, satellite multiband photos are accurate enough to be used in broad reconnaissance surveys of forest resources in appraisals of fire hazards. Similarly, color density on infrared film of selected forest types was evaluated in Missouri; in Oregon this photographic procedure was used to survey regeneration in forests. Here, the scientists were able to delineate recent clearcuts, young seedling areas, and older growth forest plantings from uncut areas. Using computer programs developed by several participating institutions, the scientists can interface resource inventory data with computers. The results are used in this way for generating resource areas, growth, or use information, and other characteristics helpful in making decisions on management alternatives. ●



*West Virginia scientists
use voice prints
(sonagrams) to census wood-
cocks. They need not catch
nor see the bird.*



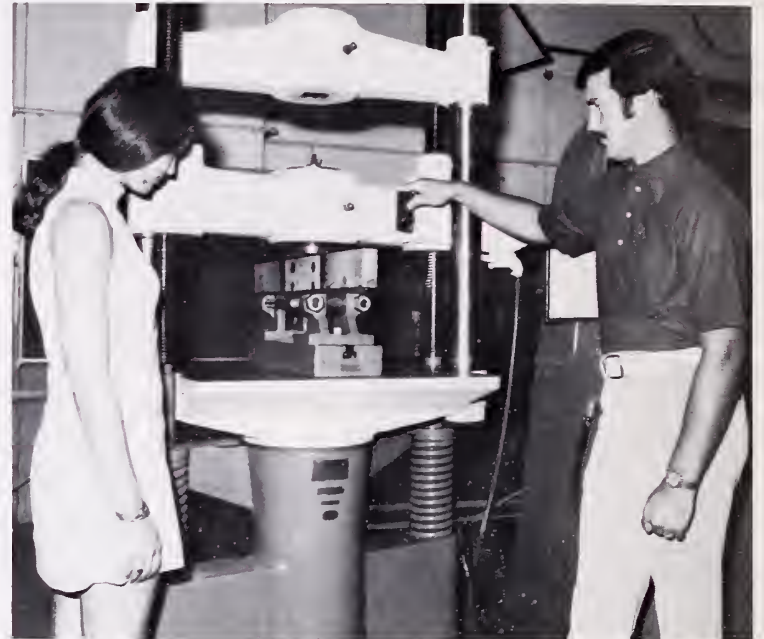
TRAINING RESEARCH WORKERS

The Congressional Act establishing the McIntire-Stennis Cooperative Forestry Research Program states “. . . that forestry schools are especially vital in the training of research workers in forestry.” Research projects and their scientist leaders constitute the critical mass of resources and competencies for meeting this goal of the program. Recent information shows that demand for forestry workers remains high. These research workers are essential to maintain the basic information useful to the growing numbers of forest resources managers charged with the Nation’s largest land management task. It is clear that the demand for forest resources can no longer be met by unmanaged (or mismanaged) forests. Requirements for timber, wood fiber, recreation, wildlife, and range resources now exceed earlier projections. In 1973, some 512 graduate students used the opportunity of working on 512 McIntire-Stennis research projects as part of their research training. The number of projects available to students declined slightly in 1973, probably because of funding uncertainty.

The scientists and graduate students generated about 450 publications from these research projects.

Copies of the publications are available from the cooperating States. Progress toward achievement of the important goal of training research workers has developed along with the other dimensions of the Program. ●

About 500 students are learning research discipline, scientific methods, and new techniques by working on over 500 McIntire-Stennis research projects. This photo shows students testing wood in South Carolina.



Student use of the computer is increasingly important in training research workers to develop modern competencies.

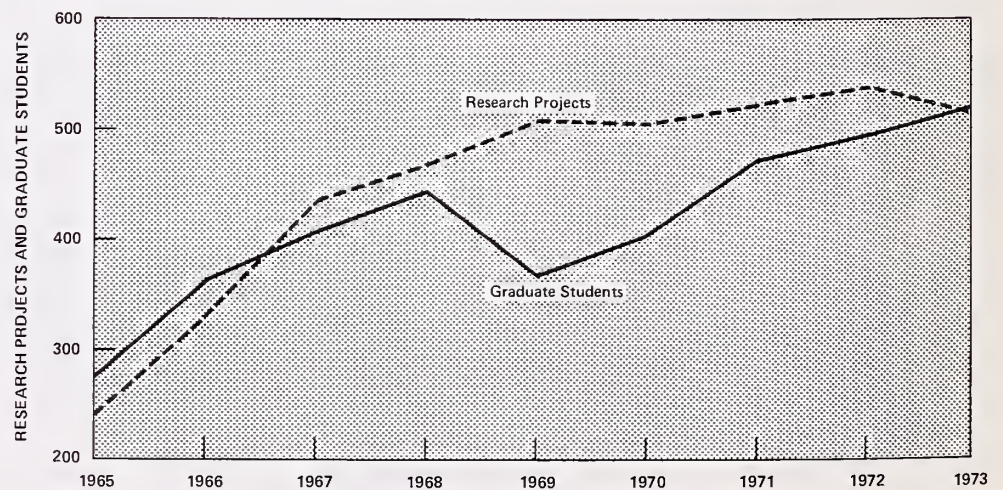


Chart 2. Projects and graduate students by year.



PARTICIPATING INSTITUTIONS

Institution	Location	Administrative Technical Representative	Representative Forestry
Auburn Univ.	Auburn, AL	R. D. Rouse	W. B. DeVall
Univ. of Alaska	Fairbanks, AK	K. M. Rae	K. M. Rae
Northern Ariz. University	Flagstaff, AZ	C. O. Minor	C. O. Minor
Univ. of Arizona	Tucson, AZ	R. K. Frevert	D. B. Thorud
Univ. of Arkansas	Fayetteville, AK	L. O. Warren	G. A. Bradley
Univ. of Calif.	Berkeley, CA	J. B. Kendrick, Jr.	J. A. Zivnuska
Calif. State Univ.- Humboldt	Arcata, CA	E. W. Pierson	E. W. Pierson
Colorado State University	Ft. Collins, CO	R. E. Dils	R. E. Dils
Connecticut Agr. Expt. Station	New Haven, CT	P. E. Waggoner	P. E. Waggoner
Univ. of Connecticut	Storrs, CT	W. C. Kennard	W. C. Kennard
Univ. of Delaware	Newark, DE	W. E. McDaniel	W. E. McDaniel
Univ. of Florida	Gainesville, FL	J. W. Sites	J. L. Gray
Univ. of Georgia	Athens, GA	A. M. Herrick	A. M. Herrick
Univ. of Guam	Agana, Guam		
Univ. of Hawaii	Honolulu, HI	L. D. Swindale	L. D. Swindale
Univ. of Idaho	Moscow, ID	J. H. Ehrenreich	J. D. Ehenreich
Univ. of Illinois	Urbana, IL	G. W. Salisbury	I. D. Holland
Southern Illinois University	Carbondale, IL	A. A. Moslemi	A. A. Moslemi
Purdue Univ.	Lafayette, IN	H. H. Kramer	M. C. Carter
Iowa State Univ.	Ames, IA	J. P. Mahlstedt	H. H. Webster
Kansas State Univ.	Manhattan, KS	F. W. Smith	R. W. Campbell
Univ. of Kentucky	Lexington, KY	C. O. Little	T. Hansbrough
Louisiana State University	Baton Rouge, LA	D. Chambers	P. Y. Burns
Louisiana Tech University	Ruston, LA	L. P. Blackwell	L. P. Blackwell
Univ. of Maine	Orono, ME	F. E. Hutchinson	F. B. Knight
Univ. of Maryland	College Park, MD	R. L. Green	R. L. Green

Institution	Location	Administrative Technical Representative	Forestry Representative
Univ. of Massachusetts	Amherst, MA	A. A. Spielman	D. R. Progulske
Univ. of Michigan	Ann Arbor, MI	J. T. McFadden	H. L. Morton
Michigan State University	East Lansing, MI	S. H. Wittwer	L. M. James
Michigan Technological University	Houghton, MI	G. A. Hesterberg	G. A. Hesterberg
Univ. of Minnesota	St. Paul, MN	W. F. Hueg, Jr.	F. H. Kaufert
Mississippi State University	Miss. State, MS	R. R. Foil	R. R. Foil
Univ. of Missouri	Columbia, MO	R. J. Aldrich	D. P. Duncan
Univ. of Montana	Missoula, MT	R. F. Wambach	R. F. Wambach
Montana State Univ.	Bozeman, MT	J. A. Asleson	F. G. Payne
Univ. of Nebraska	Lincoln, NB	H. W. Ottoson	W. T. Bagley
Univ. of Nevada	Reno, NV	D. W. Bohmont	E. L. Miller
Univ. of New Hampshire	Durham, NH	H. A. Keener	O. F. Hall
Rutgers—The State University	New Brunswick, NJ	C. E. Hess	R. F. West
New Mexico State University	Las Cruces, NM	P. J. Leyendecker	M. L. Wilson
State Univ. of New York	Syracuse, NY	R. E. Pentoney	E. E. Palmer
Cornell Univ.	Ithaca, NY	N. L. Van Demark	L. S. Hamilton
N. C. State Univ.	Raleigh, NC	E. L. Ellwood	E. L. Ellwood
N. D. State Univ.	Fargo, ND	A. G. Hazen	E. P. Lana
Ohio Agr. Research & Development Cntr.	Columbus, OH	R. M. Kottman	G. E. Gatherum
Oklahoma State Univ.	Stillwater, OK	J. A. Whatley	J. E. Langwig
Oregon State Univ.	Corvallis, OR	C. H. Stoltenberg	R. M. Kallander
Penn. State Univ.	Univ. Park, PA	W. I. Thomas	W. W. Ward
Univ. of Puerto Rico	Rio Piedras, PR	F. Sanchez-Nieva	L. F. Martorell
Univ. of R. I.	Kingston, RI	G. A. Donovan	W. P. Gould
Clemson Univ.	Clemson, SC	W. H. Davis McGregor	R. M. Allen
S. D. State Univ.	Brookings, SD	R. A. Moore	R. M. Peterson
Univ. of Tenn.	Knoxville, TN	J. A. Ewing	J. W. Barrett
Texas A&M Univ.	College Station, TX	J. E. Miller	R. G. Merrifield
Stephen F. Austin State University	Nacogdoches, TX	L. C. Walker	L. C. Walker
Utah State Univ.	Logan, UT	D. W. Thorne	T. W. Box
Univ. of Vermont	Burlington, VT	W. Christensen	W. W. Christensen
Va. Polytechnic Inst. & State Univ.	Blacksburg, VA	C. T. Wilson	J. F. Hosner
College of the Virgin Islands	St. Croix Campus, Virgin Islands	F. B. Sands	
Univ. of Washington	Seattle, WA	J. S. Bethel	S. P. Gessell
Washington State University	Pullman, WA	J. Nielson	G. A. Harris

Institution	Location	Administrative Technical Representative	Forestry Representative
West Virginia University	Morgantown, WV	H. C. Evans	D. E. White
Univ. of Wisconsin	Madison, WI	S. C. Smith	D. Lester
Univ. of Wyoming	Laramie, WY	N. W. Hilston	L. I. Painter



Native forest specimen used for Christmas trees have been improved by breeding and improved management in Vermont and other states.

For information on publications stemming from this research program, contact the Administrative Technical Representative or Forestry Representative at the participating institutions. Additional project or subject area information is obtainable from the Director, CRIS, USDA, Washington, D.C. 20250. CRIS—Current Research Information System—is a computer-based, scientific information retrieval system that is a repository of current research funded or sponsored by USDA, 53 State Agricultural Experiment Stations, 13 Forestry Schools, and 17 other cooperating institutions. ●



This super walnut tree selected in Kansas is 120 feet tall and over 30 inches in diameter. Ideal for breeding, it has no lean, sweep, spiral, or defects; it propagates easily; and its offspring grow a third faster than seedlings from other trees.



DEVELOPMENT OF SUPPORT FOR MCINTIRE-STENNIS RESEARCH

Federal funding of the McIntire-Stennis Cooperative Forestry Research Program has grown slowly but steadily since its inception in 1964. Approximately \$4.9 million of the \$6.4 million appropriated were available for research in 1973 by the State colleges and universities with forestry research programs. Research in this Program must be planned wisely and conducted efficiently if its impact is to be realized on the wise use and management of private and public forestlands within the several States. Some 296 million acres, or 59 percent of the Nation's total forestland, is managed by about 4 million private owners. The Congress realized the magnitude of research needs in the States containing this privately owned land by setting the potential funding at "one-half the amount appropriated for Federal forestry research conducted directly by the Depart-

ment of Agriculture." State research and USDA Forest Service forestry research combined provide the research base for the wise use of over 500 million acres of forestland—the largest single land use in America.

Unlike many other natural resources, forest resources are renewable. If technological advances developed through research keep pace with increasing demands on forests for their several values, shortages like those we face in energy need never occur. The goals of the McIntire-Stennis Cooperative Forestry Research Program are to develop the scientific know-how to manage the Nation's forests, meet the demand for wood and fiber, and provide abundant water, wildlife, recreation, and other values of the forest environment at the same time. ●

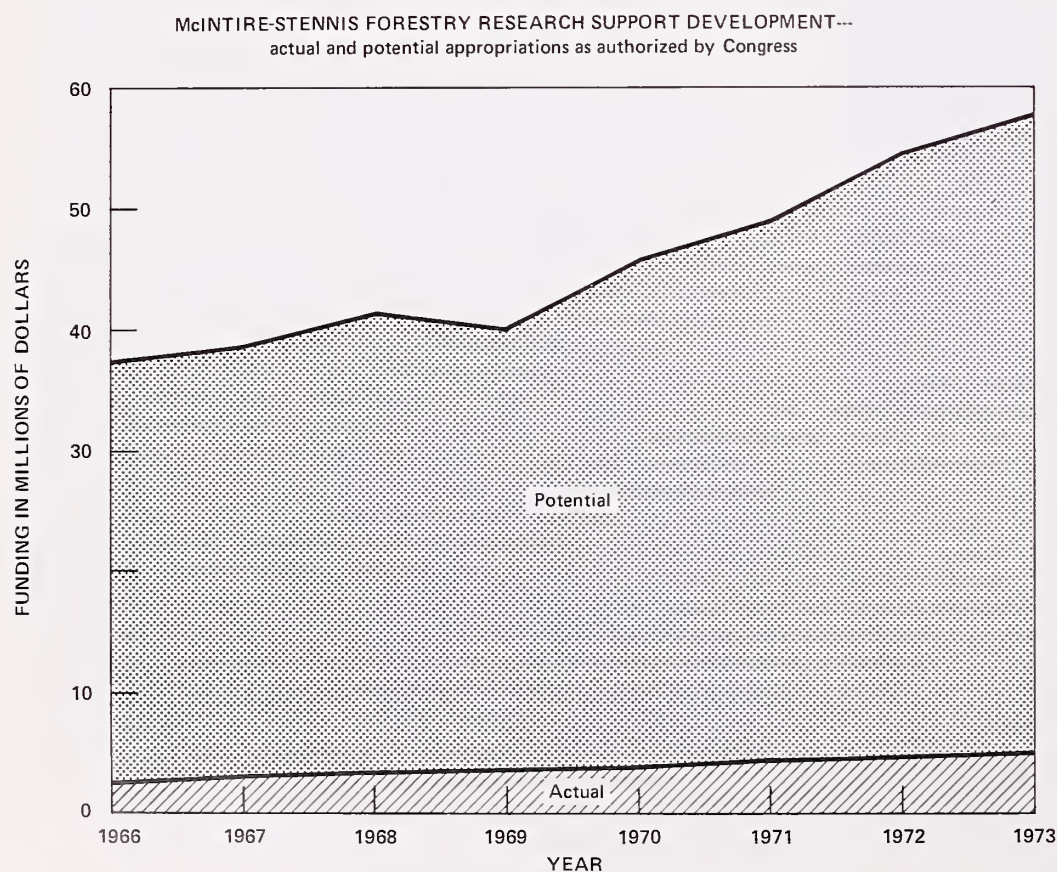


Chart 3. Funding by year.



ADJUSTMENTS IN THE MCINTIRE-STENNIS FORESTRY RESEARCH PROGRAM

Forest scientists in the States have principal responsibility for nine areas identified in the Regional-National Planning Program of USDA. Over the life of the Program, the proportion of support for forest production, protection, processing, utilization, and appraisal has remained approximately unchanged, though slight declines have characterized recent years. These result from the response of the States to the growing needs for other forest resources. Increasing proportions of the money appropriated have gone to research that

- Improves wildlife habitat and range values,

- Protects and manages watersheds to assure vital supplies of high-quality water,
- Uses forested watersheds in alleviating unsightly views, noise, and aerial contaminants,
- Recycles municipal wastes,
- Determines criteria for allocating timber land to other forest resources or to multiple use.

Forest recreation research has remained approximately unchanged although demand for recreation has continued to increase. Sustained growth of the Program should lead to adequate research coverage of all the principal forestry research areas. ●



Mycorrhizal fungi live in tree roots. Their hypha (strands) radiate into the soil as shown here in an electronmicrograph used in Colorado research. Mycorrhizae (fungus root) protects the tree from pathogens and increases its uptake of essential nutrients.

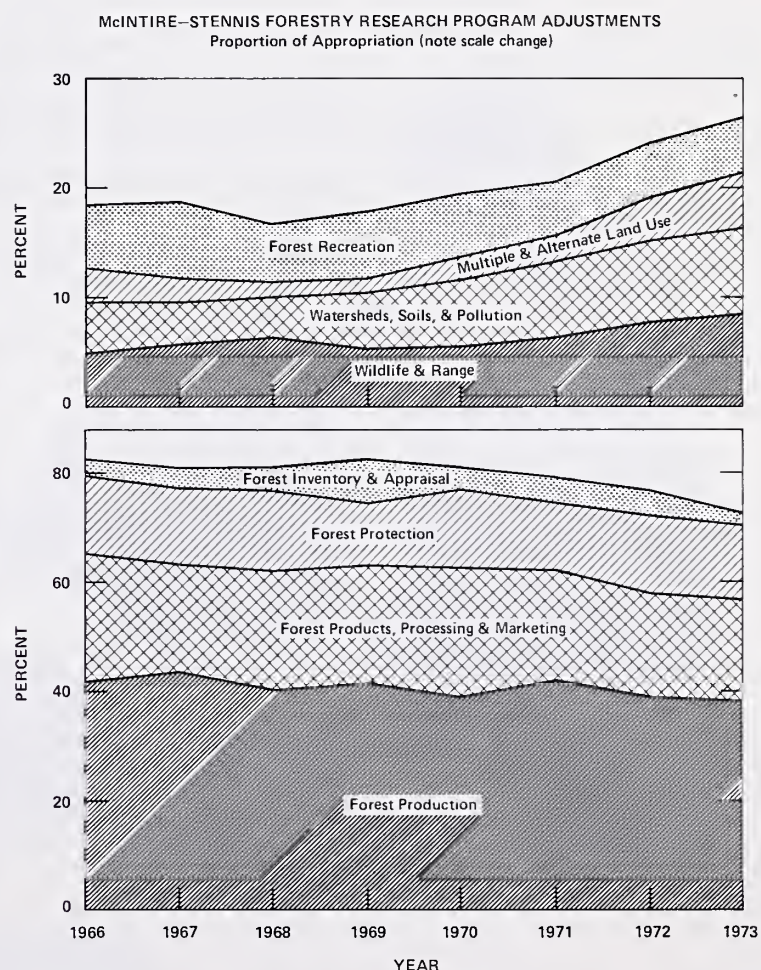


Chart 4. Program adjustments (as a proportion of appropriation—percent).



CURRENT RESEARCH EFFORT

The McIntire-Stennis Cooperative Forestry Research Program addresses several key areas important to forestry. A unique strength of the Program is its sensitivity to local and regional needs. Planning research to ensure that the Program meets contemporary needs is part of a continuous regional and national research planning effort. Groups involved are the Association of State College and University Forestry Research Organizations (ASCUFRO), the National Association of State Universities and Land Grant Colleges (NASULGC), and the U.S. Department of Agriculture. Nonparticipating schools of forestry, private industry, and other agencies with a forestry research mission also provide input. Re-

search planning task forces in the regions consist of representatives from their States. These task forces identify the critical research needs. The Program effort is adjusted in response to analyses by the various planning groups, and the Cooperative State Research Service works closely with the U.S. Forest Service to coordinate forestry research with the overall USDA program. The table shows distribution of the McIntire-Stennis research effort among the four USDA regions. Because of the extent and diversity of the forests, ASCUFRO recognizes two units in the South (Southeast and South Central) and in the West (West Central, Western). ●



MCINTIRE-STENNIS COOPERATION FORESTRY RESEARCH
EFFORT IN 1973, BY REGION

RESEARCH GROUP	REGION				
	Northeast	South	North Central	West	National
<i>Percent of 1973 Appropriation*</i>					
Inventory and Appraisal (forest, range, and remote sensing)	1.4	0.4	1.3	7.0	3.2
Timber Management (biology, culture, management, tree improvement)	27.3	39.6	50.1	31.6	38.1
Forest Protection (insects, diseases, fire)	12.2	14.0	13.6	11.2	13.1
Harvesting, Processing, and Marketing (engineering, production, product development, marketing, grades, demand and housing)	21.1	21.8	15.1	16.6	19.4
Watersheds, Soils, Pollution (soil inventory soil/plant/water/nutrient relations, watershed protection, water use, pollution abatement)	10.0	41.8	5.7	10.6	7.7
Range, Wildlife, and Fishery Resources (habitat interactions, quality, and management)	12.4	10.0	0.5	7.5	8.4
Forest Recreation and Aesthetics (demand, planning allocation, management)	3.6	1.9	8.3	6.0	5.0
Forest Land Use (alternatives, multiple-use)	10.0	4.5	4.4	5.6	5.1

* Totals are not 100 percent as some States allocate small portions to research administration.

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